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INSECTS AND THE NATIONAL HEALTH

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AT the present moment, when America is embarking on one of the most stupendous undertakings ever attempted in her history, her resources and her obligations are weighed in the balance as never before. Industrial efficiency is fast responding to the demands made upon it and human efficiency should be increased in every way possible. The latter depends, of course, primarily on bodily food, and upon the security of the moral and physical health of the nation. These together involve a multitude of minor problems, and it is upon only one small aspect of public health that I have attempted to treat in the following pages. It seems peculiarly appropriate to call to public attention the pernicious activities of insects in relation to disease, since they present a problem which can be dealt with, at least to some extent, through individual effort and small community cooperation. The importance of insects as detrimental to public health is well known to professional zoologists, medical men and laymen alike, but is usually emphasized only under the stress of particular circumstances, such as the safety of soldiers in the present war, or of unusual outbreaks of diseases for which insects are directly responsible.

Insect-borne diseases present a constant menace to the world, and aside from the actual toll of lives which they exact, they impair its efficiency by enfeebling the health of its human population. Their direful influence is more pronounced in the tropics, whence it has been most commonly proclaimed, but our own country is by no means exempt, although its cooler climate causes it to be less severely affected.

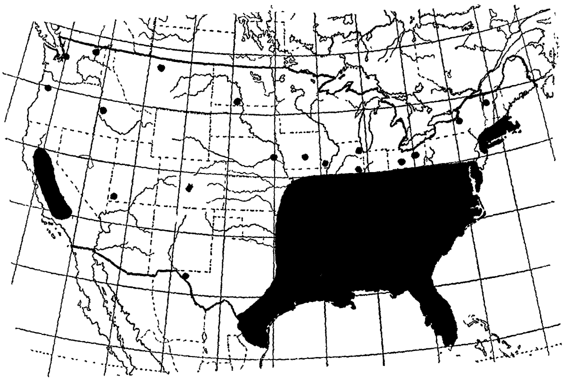
The following account is by no means complete. Its purpose is only to call attention to some of the more important disease-bearing insects in their relation to health in our own country.

Mosquito-borne Diseases.—No other insects can compete with the mosquitoes as persistent annoyers of man, and none, with the possible exception of the rat-flea, hold over him such power for evil. Practically no parts of the globe that can serve for human existence are free from mosquitoes and large areas from the tropics to the arctic are periodically invaded by them in varying abundance. Even where irrigation has made the "desert blossom like the rose" it has often also produced a crop of mosquitoes to annoy or even afflict with disease the inhabitants of the garden.

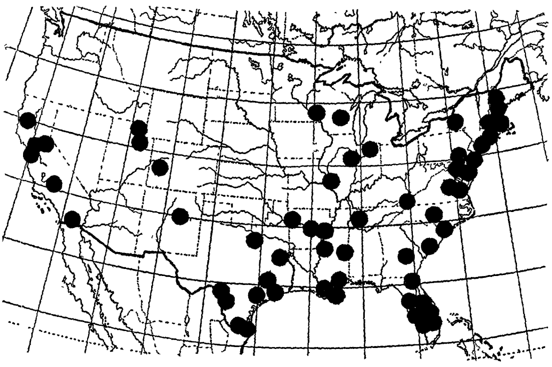
On account of their phlebotomic habits, and particularly their hominophilous tastes, mosquitoes have always been heartily detested, even by entomologists, and only their known association with human diseases has brought them to the serious attention of zoologists. With this incentive, however, a vast amount of work has been done by entomologists and medical men and an enormous mass of literature has been produced in less than two decades, bearing on every conceivable aspect of the subject. We now know that mosquitoes are responsible for many deaths, much human misery and great economic loss through their activity as disseminators of malarial fevers, yellow fever, dengue fever, filariasis, etc.

In all of this, several of the more important relations of mosquitoes to public health stand out very clearly. They are: (1) Some very important diseases of man are transmitted by certain specific mosquitoes, the latter being absolutely necessary for the continued existence of these diseases. (2) The disease-bearing mosquitoes are most widely distributed in the tropics, whence they extend into portions of the temperate zones. (3) The range of mosquito-borne diseases is not necessarily coextensive with the distribution of their insect carriers, but is dependent upon other factors as well. (4) Mosquito-borne disease may be combated either by the elimination of the mosquito responsible; by the protection of the population from its bites; by the careful screening of human patients to prevent them from infecting mosquitoes; or by a medical prophylaxis or immunization of the susceptible population. (5) Remedial measures are preferably applied against only the specific mosquitoes responsible, not against mosquitoes in general. The last is primarily a matter of economy, that the most vital needs of the community be first fulfilled; often more willingness on the part of the community is evinced to cooperate in fighting the most annoying or abundant species of mosquitoes rather than the ones most deleterious to the public health.

Of these methods, the first has proved the most generally



MAP 1. DISTRIBUTION OF MALARIA IN THE UNITED STATES (after Trask).



MAP 2. DISTRIBUTION OF MALARIAL MOSQUITOES IN THE UNITED STATES.

applicable, preferably combined with the second and third. The last has not proved generally suitable even with malaria, where quinine is a specific remedy, or with plague, where immunization is possible.

Malarial Fevers.—At the present time malaria in its several forms is the veritable scourge of the tropics. It also extends generally into the sub-tropics and warmer temperate regions and is prevalent over a considerable part of the southern United States. In these areas, as appears from investigations of the U. S. Public Health Service, its range is roughly coincident with the moist austral zones east of the 100th meridian as defined by Merriam. Aside from this main area, there is a small one in southern New England and another in central California; there are also a few isolated localities scattered through the country where malaria is thought to be endemic (see Map 1). At least three species of *Anopheles* are known to act as carriers of malaria in the United States and, from data given by Howard, Dyar and Knab (see Map 2), the distribution of these taken together corresponds closely with that of malaria, although slightly more extensive, especially along the Atlantic seaboard. As these malarious regions include a population of about 40,000,000 people, it will be seen that the importance of malaria from the standpoint of public health is very great indeed. It must be remembered, however, that the incidence of malaria varies widely, being greatest in the large southeastern area, and very much less in the more densely populated northern district. Thus in Mississippi about 80 cases of malaria per 1,000 of population were reported during the last year, or 158,000 for the entire state. Other southern states do not report the disease so thoroughly and it is difficult to estimate to what extent they are affected. It would seem, however, that one million cases each year would be a conservative estimate, especially as von Ezdorf found in a portion of one mill town in the endemic area that over 13 per cent., or one person in seven, harbored the malarial parasite in the blood, while 233 out of 500, or nearly 50 per cent., reported having had chills and fever during the summer preceding his examination. Although the death rate from malaria outside the tropics is not very great (9 per 1,000 calculated on the data for Mississippi cited above) it is by no means inconsiderable in the mass. On the other hand, the economic loss is enormous, due to inability to work during the acute attack of the fever and due to a loss of efficiency during prolonged periods following. That malaria responds quickly to anti-mosquito work and quininization is shown by the result following an application of these measures to the mill town mentioned. Referring to von Ezdorf's report, Trask says:

> Measures were inaugurated to get rid of mosquito-breeding places and the use of quinine was encouraged. A year later the town was again visited and the blood of 780 person examined. Of these only 35, or 4.5 per cent., showed infection. The health officer reported at this time that his visits among the mill employees for several months had averaged not over one a day, and that many of these were undoubtedly for old infections lasting over from previous years. The malaria rate had continuously decreased during the months when it was usually at its worst. The health officer of the town in his report for 1914 stated that while during the summer of 1913, prior to antimalarial work, the mills were constantly short of help on account of the large numbers of employees sick with malaria, during the summer of 1914 there had not been a day when the mills did not have sufficient help. The manager of one mill stated that the improvement in the regularity and efficiency of the employees had been such that the amount ($1,000) which the mill had contributed to the fund for anti-mosquito work was more than regained in one month's operation.

While these conditions are those of one of the most severely affected districts, they are nevertheless repeated very generally throughout the entire area, more especially in the lowlands, for the hilly or mountainous and better-drained sections suffer less.

As mentioned above, several species of *Anopheles* mosquitoes are concerned in the transmission of malaria in the United States. Till very recently only one species, *Anopheles quadrimaculatus,* has been thought to be of much importance. Recent studies by Mitzmain and others show that this mosquito is the most important, as it may harbor the parasites of all three types of malaria, but *Anopheles punctipennis* (Fig. 1), a common, widespread species and *Anopheles crucians,* a species abundant along the eastern coast of the United States, may serve both as hosts for the tertian and estivo-autumnal or subtertian forms. The ease and frequency with which *A. punctipennis* may become infected seems to vary greatly under different conditions and its importance at least in northern districts is by no means proved.

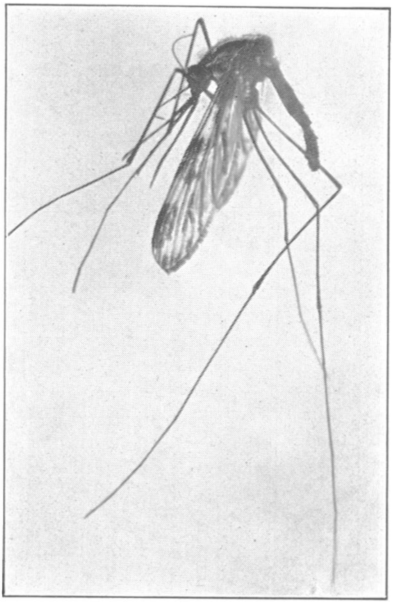


FIG. 1. *Anopheles punctipennis,* female.

All three species readily enter houses and are persistent biters, although no more so than some other mosquitoes. Both *quadrimaculatus* and *punctipennis* breed in stagnant water, usually that of permanent nature containing algæ or other plant growth. They commonly occur together, with *punctipennis* usually more abundant. Larvæ of the latter species occur also rarely in temporary puddles and both are occasionally to be found in the growth along the sides of slowly flowing streams. The breeding grounds of *A. crucians* are mainly restricted to regions adjoining the salt and brackish marshes along the coast, although the larvæ are most abundant in fresh water. The two *Anopheles* occurring on the Pacific coast region, *A. pseudo-punctipennis* and *A. occidentalis,* have habits similar to those of *quadrimaculatus,* although the second species breeds in brackish waters also. As is the general habit among adults of *Anopheles,* these mosquitoes feed mainly at twilight and malaria is acquired only by persons who expose themselves to their bites after nightfall. Occasionally they bite during the daytime, but as malaria appears never to follow such bites it seems probable that only newly emerged females and consequently non-infected ones bite at this time, as is the case with the yellow-fever mosquito.

Like other insect-borne diseases, malaria shows in its seasonal prevalence a close relation to the seasons (see Fig. 2), undergoing a period of quiescence during the winter and attaining a sudden maximum in late summer, after which it rapidly declines. This is in response to the increasing abundance of *Anopheles* during the summer, coupled with a relatively high temperature, favorable for activity on the part of the mosquito and for the development of the malarial parasites in its body. It has recently been clearly shown by Mitzmain that under the conditions of temperature prevailing in the United States the malarial parasites do not persist through the winter in hibernating mosquitoes, but winter over in the human host from whence the *Anopheles* secure them the following season.

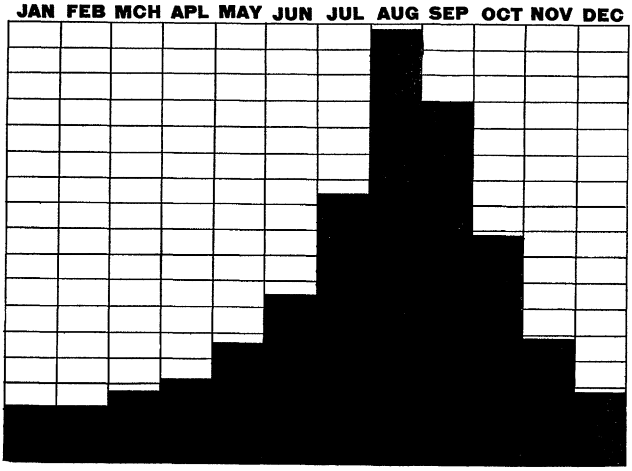
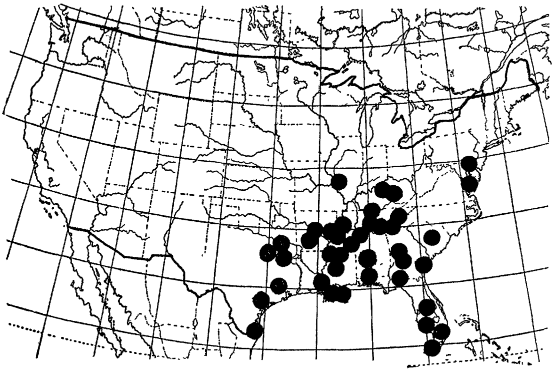


FIG. 2. SEASONAL PREVALENCE OF MALARIA IN THE UNITED STATES.

As already pointed out, the reduction of malaria in communities is permanently accomplished most readily by the application of anti-mosquito measures, aimed mainly at the breeding-places of *Anopheles* mosquitoes. Such work is being extensively carried on by the U. S. Public Health Service, by other federal bureaus, by many state boards and commissions, and by certain private or semi-private institutions in widely scattered parts of the country. Through their individual and collective efforts an enormous amount has been accomplished, although painfully little in comparison with what could well be spent upon the problem, which is without question one of the great public-health problems in the United States at the present time.

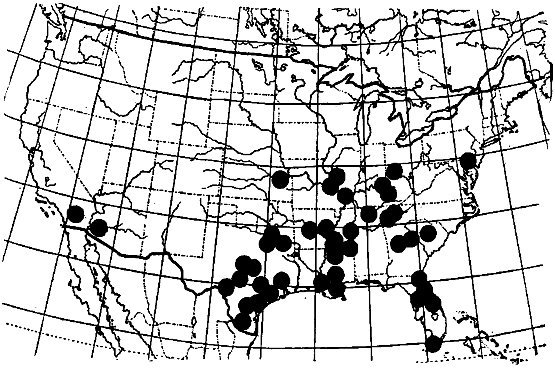
Yellow fever no longer causes serious concern to residents of any part of the United States, or, for that matter, to those of most parts of the American tropics. Most of us can recall very clearly in the not far distant past, however, the terror and demoralization which accompanied its periodical appearance in our southern ports. The yellow-fever mosquito is still abundant and widely distributed throughout the southeastern states (see Map 3) and sometimes becomes temporarily established further north during the summer. There is no yellow fever, except an occasional stray case from the tropics, which does not get beyond the keen eyes of the Public Health Service, and consequently our population of yellow-fever mosquitoes remain free from the dread disease. In this case several factors have combined to make possible the elimination of the disease without more than temporary and local eradication of the mosquito. In our southern states the disease does not easily survive the winter and chronic human carriers do not exist, so that past outbreaks have been due to fresh introductions and have been terminated by cold weather. During the last epidemic that occurred in New Orleans, in 1905, vigorous anti-mosquito measures were necessary, but, due to the greater severity of the disease, the consequently greater ease with which it is recognized, the limited area to be dealt with, and the absence of chronic human carriers, the eradication of yellow fever without permanent mosquito repression has been easy in comparison with the control of malaria. Even in parts of the tropics where it persists throughout the year, it is being rapidly and permanently eliminated. Indeed it bids fair to be the first disease actually to become extinct as a direct result of human discov-



MAP 3. DISTRIBUTION OF THE YELLOW-FEVER MOSQUITO IN THE UNITED STATES.

ery and applied science. What a refreshing contrast to the fate of the American pigeon and the forlorn remnants of the American bison!

Another tropicopolitan, semi-domesticated mosquito extends quite widely into the warmer parts of the United States (Map 4). This is *Culex fatigans*, now known as *Culex quinquefasciatus* (Fig. 3), mainly, if not entirely, responsible for the transmission of a parasite of the blood-stream and lymphatics causing filariasis or elephantiasis. In this connection it is of small importance to us, as this disease is very uncommon in the United States, but as a carrier of dengue fever or "break-bone fever" it is of considerable importance. Dengue is a mild



MAP 4. DISTRIBUTION OF *Culex quinquefasciatus* IN THE UNITED STATES.

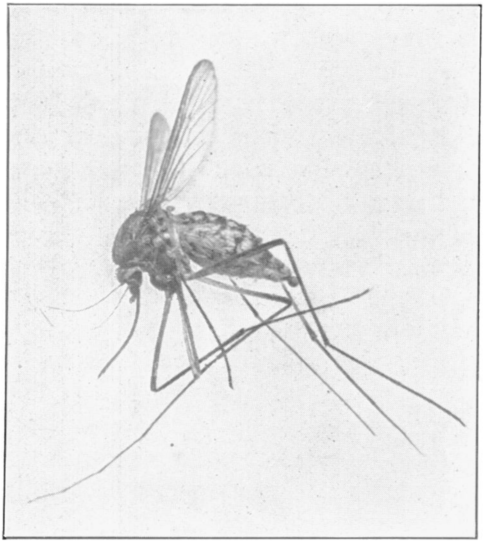


FIG. 3. *Culex quinquefasciatus,* female.

(*i. e.*, non-fatal) disease which causes great distress and temporary disability. It is therefore a factor contributing to lack of efficiency and goes hand in hand with malaria in this respect. Like malaria, dengue is tropicopolitan in range, and extends only into the warmer parts of the south. Here it sometimes appears in extensive epidemics, but in a much more erratic way than malaria, which has the well-deserved reputation of appearing year in and year out in the same districts. This difference is probably due to the absence of chronic human carriers and the fact that *Culex quinquefasciatus* does not breed in permanent water, but in an almost truly domesticated species which breeds in temporary water near human habitations, and under the climatic and other conditions of our country does not find anything like uniform opportunities for breeding from one season to another. In consequence of their separate breeding-grounds, measures designed to control malarial mosquitoes have no effect or practically none upon the dengue mosquito. It must be dealt with mainly by education leading to individual effort and cooperation in communities. Aside from its pathogenic possibilities, this species is a rather persistent biter, which is another argument for its control.

Less directly detrimental to public health are other mosquitoes not associated with any human disease, but making life miserable at some season of the year for human beings in practically all parts of the world. Although the United States supports an extensive mosquito fauna, a very few species aside from those already mentioned make up the bulk of those annoying man. Two particularly are widespread, abundant and on account of their strikingly different habits, perhaps worthy of mention in this connection. The first of these is the house mosquito, *Culex pipiens,* a palearctic species, now common throughout the eastern states, that breeds in rain-barrels, cesspools, sewer-catch-basins, puddles or practically anywhere, no matter how foul the water. The other, *Aëdes sollicitans,* the salt-marsh or "Jersey" mosquito, breeds only along the coast in salt-marshes. Broods of this mosquito follow the lunar calendar, developing after the high tides flood the meadows and fill the pools in which the larvæ live. The eggs of this form are laid on the mud and hatch quickly when submerged in water. It is generally believed that all the eggs laid by this mosquito must pass the winter before hatching and that the successive broods are only installments of eggs induced suddenly to hatch in turn by successive wettings. This is a true migratory mosquito, which invades the country for many miles adjacent to the salt-marshes. Such incursions follow the appearance of each brood.

Much attention has been given to the control of this mosquito in New Jersey and the territory surrounding Long Island Sound, and its numbers have been marvelously lessened through the drainage of marshes by ditching. In the case of this species reforms have been easier than with the malarial mosquitoes, as an expectation of relief from the great personal discomfort of myriad mosquito-bites exerts a stronger appeal to the average person than the much more important health problem of malaria. In the public mind, the latter is unfortunately not usually regarded as so immediately personal, as the fever and the bite are not coincident.

Black-flies.—At some time during the insect season, usually in the spring, many districts are visited by swarms of small hump-backed flies which viciously bite man and animals alike. On account of their dark color these have been called black-flies. They pass their developmental stages almost entirely in swiftly moving brooks and streams, where the larvæ and pupæ are attached to stones and other objects in the water. Wherever there are suitable streams in which they can breed, these pests appear abundantly, and may be occasionally present far from streams, where they would not be expected. They are not known to be concerned in the transmission of any disease.

Biting-midges, Sand-flies, Etc.—Minute flies, somewhat like mosquitoes, which are vicious blood-suckers, often appear in great abundance, particularly in the cooler parts of the United States. These insects belong to several genera, developing from aquatic larvæ inhabiting fresh water and also brackish water along the sea-coast. They are generally crepuscular, biting most abundantly at dusk, and are very persistent at that time, causing a stinging sensation out of all proportion to their almost microscopic size. None of our species are known to be disease-carriers.

Housefly Diseases.—Of these it may be urged that, strictly speaking, there are none, at least in the sense of mosquito-borne diseases. The housefly is not known to be wholly responsible for the transmission of any disease and its relative importance in disseminating several infections of man is still a moot question. By some it is strongly urged as the main means of transmission for several enteric diseases in certain communities; by others it is cast aside without reasonable consideration as a sort of entomologist's nightmare. I can not believe that either course is justified; each seems to be based on prejudice due to lack of knowledge, either respecting the fly or relating to other channels of infection.

The housefly (Fig. 4) is more truly domesticated than any other insect; it lives and flourishes wherever man establishes himself, but does not thrive elsewhere. It has evidently been associated with him from the remotest antiquity, but has by no means failed to adapt itself to changed conditions. It still develops in his feces or those of his domestic animals and still invades his habitations to partake of his food. In short, it is practically ever-present, for its preferred larval food, horse manure, is usually to be found, and, if not, substitutes are available in greater or less abundance.

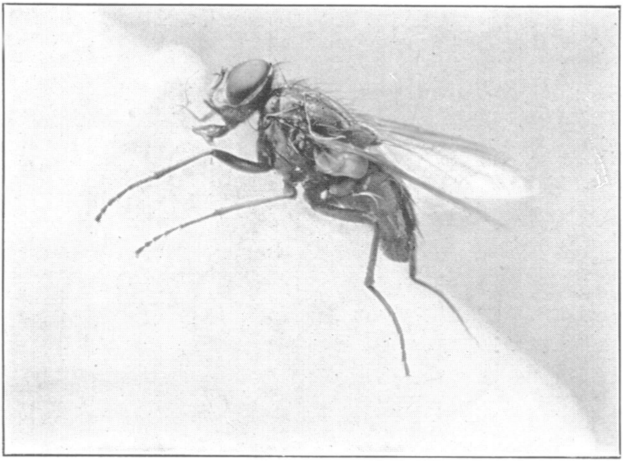


FIG. 4. HOUSE-FLY FEEDING ON A LUMP OF SUGAR.

The chain of events through which the housefly may infect food with bacteria or other organisms derived from excremental materials is obvious and has been so repeatedly described that it is unnecessary to outline it here. The frequency with which this actually happens is of course the vital point, and it is upon this that it is very difficult to obtain concise data.

It has been shown rather conclusively that adult flies do not retain in the alimentary tract bacteria which they may have ingested as larvæ that have developed and fed in material containing, for example, the bacillus of typhoid fever. On the other hand, adult flies readily obtain this bacillus from contaminated substances and may retain and later deposit it in a living condition on food designed for immediate human consumption. There can be no question but that this occurs commonly under many circumstances, particularly in communities where there is no adequate system of sewage disposal. That these bacteria should be more attenuated than those occurring in drinking water does not seem probable. Many facts show that flies are a very important factor in the dissemination of typhoid fever. The greater frequency with which persons on country vacations contract the disease is very striking, although this may, of course, be attributed to bad water supply. Other opportunities for infection, aside from the fly, are, however, no greater there than in the city. In other parts of the world where the water supply is reasonably good, *e. g.*, certain South American cities, typhoid flourishes to an alarming extent, due undoubtedly to excessive soil pollution, where flies can almost instantly transfer material from typhoid carriers to food, while the latter is abundantly exposed on the streets for sale to be eaten on the spot. In our own country the seasonal incidence of typhoid fever corresponds to some extent with fly prevalence, and still more significant is its greater summer prevalence in regions where systems for sewage disposal are not generally installed. This disparity is shown on the accompanying chart (Fig. 5), which gives data for two of our eastern states, New York and Alabama, and one western state, Washington. The greater uniformity throughout the year in New York, where the opportunities for fly-borne infection are curtailed, is very marked. Another way in which the housefly can aid in the spread of typhoid is through infecting milk on dairy farms where carriers are present and offer the flies a chance to become infected.

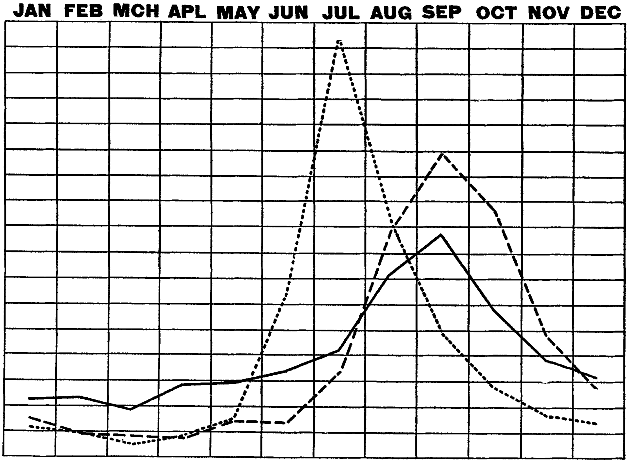


FIG. 5. SEASONAL PREVALENCE OF TYPHOID FEVER IN SEVERAL STATES; solid line, New York; dotted line, Alabama; dashed line, Washington.

Flies are also responsible, and to a much greater extent, for the prevalence of infantile diarrhea or summer complaint, and here their relation is very easily seen.

Other activities of houseflies detrimental to public health are of far less importance, but by no means negligible. They can carry the eggs of parasitic worms as well as many bacteria and other microorganisms present in the several types of unsavory food upon which they feed indiscriminately.

Recently much progress has been made in methods of abating the housefly nuisance. It has been found by workers in the Federal Department of Agriculture that certain substances, notably borax, hellebore, and a fertilizer consisting of calcium cyanamid, acid phosphate and kainit, are highly destructive to fly-larvæ in horse manure (whence the great majority of our house-flies come) and that these substances do not ruin the manure for agricultural purposes. Practical traps whereby fly-larvæ in stored manure may be caught and destroyed before transformation have also been devised. Richardson has shown that house-fly larvæ can develop only in alkaline material, and some substances may thus be acidified to eliminate them as larval food.

The people of the United States spend great sums of money for fly-screens, fly-paper, fly-swatters and fly-traps and suffer much sickness and death as a result of the ubiquitous housefly. As yet no great reduction of houseflies has been accomplished, but the public regards them less and less as harmless creatures, and should soon be in the proper mental state to launch a decisive campaign against them.

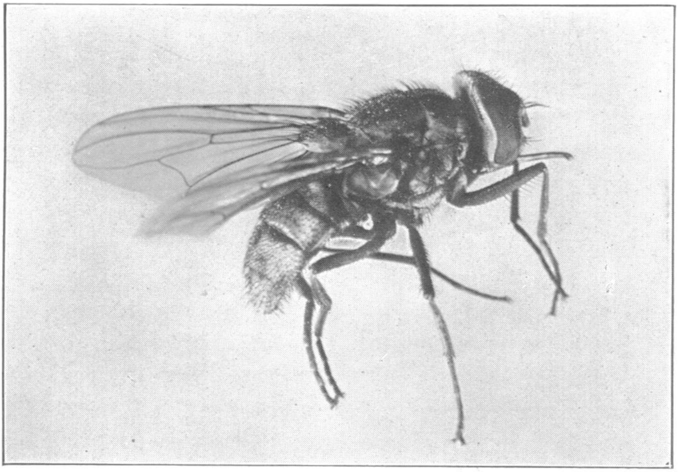


FIG. 6. STABLE-FLY (*Stomoxys calcitrans*).

The Stable-fly.—Cattle, horses and other domestic animals, and more rarely man himself, are troubled in nearly all parts of the world by a small blood-sucking fly resembling the house-fly in size and general color (Fig. 6). On account of its great abundance about horses and cattle it has been termed the stable-fly, although its larvæ breed mainly in fermenting vegetable material rather than in manure. The adult flies readily bite human beings, particularly in damp weather, and this habit has given rise to the popular idea that house-flies bite before a shower. The stable-fly is most important as a pest of animals, as it has not been definitely proved to be more than an accidental carrier of any disease affecting man. It was at one time thought to be a carrier of poliomyelitis (infantile paralysis), but it now seems probable that such it not the case.

Typhus Fever.—Although this louse-borne disease is of prime military importance in some parts of the world, it is practically non-existent among the civil or army population of the United States. That it should ever be revived seems unbelievable, for it has passed from the proportions of gigantic epidemics in the middle ages to insignificant local outbreaks, corresponding to the continuous improvement of sanitary conditions in our own and other countries. The relaxation of such checks in war-ridden countries has always spelled a temporary increase in typhus. We have every reason to foresee, however, during the present war less typhus than would have been thought possible were the manner of its transmission by lice not known.

Rocky Mountain Spotted Fever —This is the only definitely characterized tick-borne human disease that occurs within the confines of the United States, although ticks are responsible for the transmission of several other important infections of man in various parts of the world. Rocky Mountain spotted fever is restricted to the far western and northwestern states, whence 290 cases were reported during the year 1916. Over half of these occurred in Idaho, although the disease extends into the neighboring states of Montana, Wyoming, Colorado, Utah, Nevada, California, Oregon and Washington, as well as northward into Canada. As shown by the indicated fatality rate, the disease is most virulent in western Montana and northern Idaho, where the mortality is said to reach 70 or 80 per cent. A single species of tick, *Dermacentor venustus* (Fig. 7), common in these regions is known to act as the vector. The *Dermacentor* ticks occur abundantly on various small wild mammals in the younger stages and as adults on domesticated animals, such as cattle, and from these become transferred to man. It has been experimentally shown that certain rodents are susceptible to the disease, and that a tick thus infected in the nymphal stage can retain the disease organism till it becomes adult. It may then reach its human host through the medium of domesticated animals such as cattle. It appears that this is the ordinary way in which human cases have their origin, *i. e.*, through the bites of adult ticks, although the newly hatched "seed ticks" derived from eggs laid by infected mother ticks are known to contain the organism also.

Although Rocky Mountain fever is of minor importance at present, it is feared that it may increase its range at any time, since other ticks of wider distribution are apparently capable of acting as carriers. Whether this may happen is by no means certain, however, and the vigorous measures already undertaken to reduce the abundance of ticks on domesticated animals will undoubtedly bear fruit in the gradual reduction of this locally much-dreaded disease.

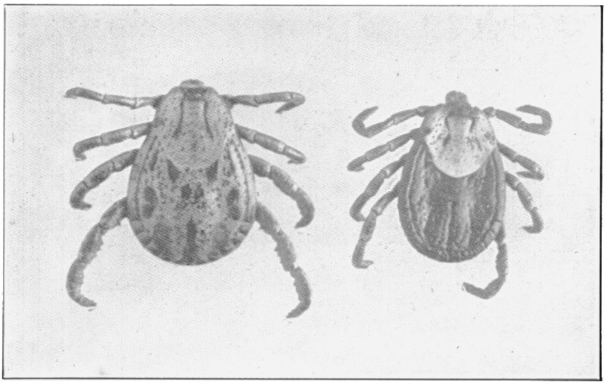


FIG. 7. ROCKY MOUNTAIN SPOTTED-FEVER TICK, male at left. Unengaged female at right.

Bubonic Plague.—From 300,000 to 400,000 cases of this disease are reported from India every year, over half of which terminate fatally. In past centuries it periodically visited many parts of the world as epidemics of even greater proportions, causing it to rank as one of the worst scourges of mankind. As is now well known, plague is a disease of rats which becomes transferred to man almost exclusively through the agency of fleas. At the present time it is most widespread and abundant in tropical countries, although by no means confined to them, and is excluded from our own country only by dint of repressive measures administered with the greatest thoroughness. Within the past few years it has appeared only sparingly in the United States, but at several times has given rise to a temporary apprehension lest it pass beyond control. That

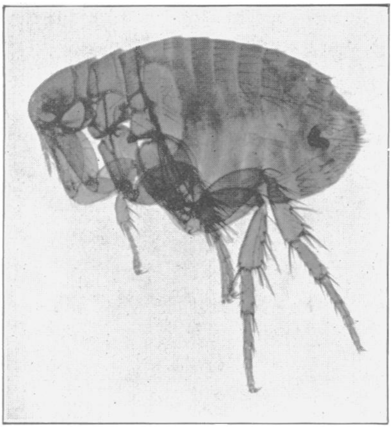


FIG. 8. TROPICAL RAT-FLEA (*Xeno psyllacheopis*).

it has not done so shows that the probability of future danger is remote.

Nevertheless there are other good reasons why we should spare no efforts in reducing the number of rats. They are said by Nelson to destroy annually $200,000,000 worth of our foodstuffs and other property; they constitute a fire-menace, and, besides, they can hardly be considered as deserving our hospitality from an esthetic standpoint. In short, war against rats is important for many reasons, one of which is the security against plague which it entails, and gradual repression through individual effort is much easier than intensive campaigns necessitated by the advent of plague in a community.

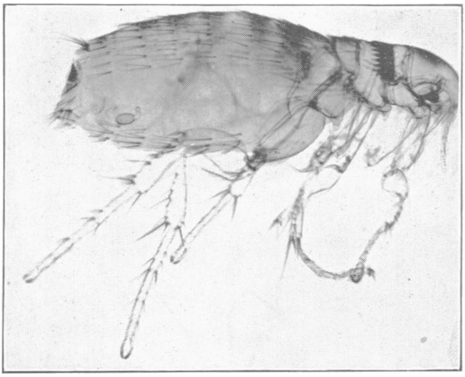


FIG. 9. RAT-FLEA OF TEMPERATE REGIONS (*Ceratophyllac fasciatus*).

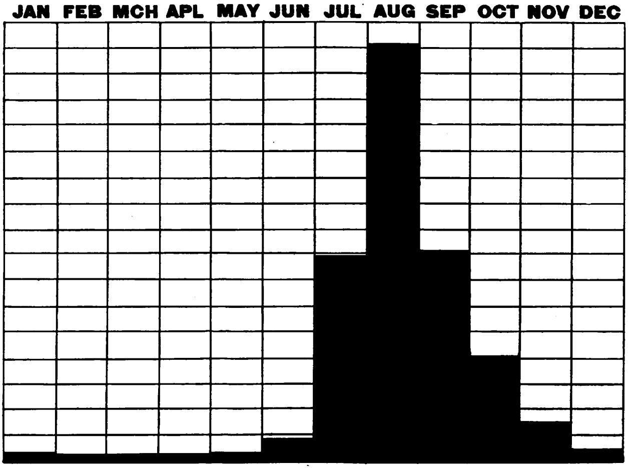


FIG. 10. SEASONAL INCIDENCE OF INFANTILE PARALYSIS IN THE UNITED STATES DURING 1916.

The relation of the flea to the transmission of plague is due to the fact that rats are regularly infested by fleas that may become infected with the bacillus of plague, if it be present in the blood of the host upon which they are feeding. These bacilli remain in a viable condition for some time in the gut of the flea and may be transferred to a human subject bitten by an infected flea. Thus, when a rat dies of plague, its fleas leave it to search for a new host; if they attach themselves to a rat, that animal is liable to infection, or if they feed upon a human being, as they frequently do, the disease may become transferred to man. Two species of fleas are commonly concerned in the transfer, one in tropical and subtropical regions and another in temperate regions. The tropical rat-flea, *Xenopsylla cheopis* (Fig. 8) is thus of greatest importance in the warm countries where it is most abundant, and the other, *Ceratophyllus fasciatus* (Fig. 9), in cooler countries. Both occur in the United States, neither specifically associated with plague except as previously outlined; other fleas may act as carriers equally well, but are not so abundant on rats and do not bite persons so frequently.

Infantile Paralysis.—Perhaps a few words in regard to this baffling disease may not be amiss. There are strong reasons for believing that it is carried by insects. Its summer prevalence (Fig. 10) is well known and its general distribution and occurrence are similar to those of insect-borne diseases. That it may be proved to be spread by the rat-flea is not improbable, and if so, would be another strong argument for the reduction of our rat population.